Training Extension Course Validation

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This report presents the results of an analysis of sample training extension course (TEC) validation efforts. The conclusion of the report is that subject matter expert input and the use of hands-on testing are critical to the success of validation efforts. Validation could also be improved through confirmation of the validity of training doctrine, through use of more adequate resources, through the random selection of samples, and through acquiring a better understanding of the target audience.

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FOREWORD

This task report is one of several provided by the Mellonics Systems Development Division of Litton Systems, Inc., to the Army Research Institute for the Behavioral and Social Sciences (ARI).

Under the provisions of the contract, a part of the Mellonics effort supports the ARI evaluation of the Army Training Extension Course (TEC) Program. The research comprises investigations concerning current and projected usage of TEC in the Active and Reserve Components of the Army, training effectiveness and the retention of TEC instruction, current and projected costs of the TEC program, the cost-effectiveness of TEC in improving individual and unit performance, and the development of a TEC Manager's Guidebook.

This report seeks to determine the effectiveness of the current practices and procedures used by the service schools to validate TEC lessons. An evaluation of the validation procedures observed at five service schools is presented in this volume.

TRAINING EXTENSION COURSE VALIDATION

EXECUTIVE SUMMARY

Requirement:

To investigate and determine the effectiveness of current practices and procedures used by service schools to validate TEC lessons.

Procedure:

During the period August to November 1978, TEC validations being conducted by five different service schools were observed.

Findings:

The validation guidance contained in the TEC Manager's Guidebook is used as the basis for planning TEC validations. Several deviations from the prescribed procedures were observed; however, these adjustments were the results of conscious decisions made with the intent of facilitating mission accomplishment with available resources. The lack of subject matter expert (SME) influence during lesson development and the failure to use hands-on performance tests in validations has an adverse impact on the quality of completed TEC lessons.

Utilization:

This report describes several shortcomings associated with the current practices and procedures used in TEC lesson validations and presents suggested modifications.

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TRAINING EXTENSION COURSE VALIDATION

INTRODUCTION

GENERAL

The Training Extension Course (TEC) program has been designed to put into the hands of trainers, both in units and in institutions, high quality performance-oriented multimedia training packages. It is designed to provide soldiers with immediate access to self-paced instruction especially designed to assist them in acquiring and maintaining skills critical to the performance of their job in combat. TEC lessons are designed for use on an individual basis; however, they may be used by small groups, under the supervision of an NCO.

The advent of the TEC program inaugurated a multi-faceted TEC research effort conducted under the sponsorship of the U. S. Army Training Support Center (USATSC), by the U. S. Army Research Institute for the Behavioral and Social Sciences (ARI) and the Mellonics Systems Development Division of Litton Systems, Inc. The research comprises investigations concerning current and projected usage of TEC in the Active and Reserve Components, training effectiveness and retention of TEC instructions, current and projected costs of the TEC program, cost-effectiveness of TEC as it relates to individual and unit performance, and the development of a TEC Manager's Guidebook.

The requirements of this effort are to determine the current practices and procedures used by the service schools to validate TEC lessons. As a basis for discussing TEC lesson validations, the validation chapter of the U. S. Army Training Extension Course Manager's Guidebook is reviewed.

VALIDATION GUIDANCE

The TEC Manager's Guidebook provides general procedural guidelines for TEC lesson validation, which is a training effectiveness evaluation. The iterative process of lesson development and the subsequent testing of instruction work together to create, through trial and revision, training effective TEC lessons for job relevant tasks.

The training effectiveness evaluation, if properly conducted, insures that the instruction teaches; i.e., a majority of the target audience achieves the learning objectives at a specified criterion level. If the training objectives are properly determined, the soldiers will also be able to perform the required tasks at a criterion level. These objectives are derived directly from the complete task analyses of soldier's jobs. Nevertheless, the TEC Manager is responsible for verifying the validity of the training objectives.

Subject Matter Experts (SME's) should, as a minimum, confirm the validity of the content of all training objectives. The SME should establish the validity of the content by systematically checking that the objectives have been derived from an analysis of what the soldier must do in order to perform the task taught in the lesson.

The TEC Manager's Guidebook specifies that the training effectiveness of a lesson is measured in terms of the pre- and posttest accompanying it. The difference in posttest scores over pretest scores is a direct measure of how well the lesson trains. The pre- and posttest are to be validated to insure that they are measuring what is intended to be measured. This reduces error in testing and lesson development, and increases the probability of effectiveness of the TEC lesson.

Pre- and Posttest Development. The responsibility of a TEC lesson evaluator begins when training objectives are translated into criterion-referenced test items. For example, the training objective--field strip the M16 rifle in total darkness within 2 minutes--is measured by criterion-referenced and performance test items. These items record the GO/NO GO of the field stripping and the time required to perform it. In the TEC lesson development process, the criterion-referenced test items are developed prior to the design of the lesson itself; then these test items are incorporated into the pre- and posttests. Without a valid test, there is no way to measure the training effectiveness of a lesson.

Pre- and posttests may be one or a combination of two types of tests; a paper-and-pencil test or a performance test. If a performance component is not incorporated into the pre- and posttests, a performance test or a separately validated written test must be included in addition to the pre- and posttests for the purpose of evaluating training effectiveness.

   o Validity and reliability. Validity and reliability
      are the two elements that describe the utility and

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accuracy of a test. Validity is the most important
aspect of any type of test. Test validity is defined
as the degree to which a test measures the performance
it was designed to measure. Test reliability is de-
fined as the consistency of the measure. This means
a given test, no matter what it is measuring, produces
the same value (score), or one very close, every time
a person takes the test. Tests used for TEC lessons
must be both reliable and valid. They must consistently
measure the effectiveness of the lesson with respect
to the soldiers' real performance requirements.

o Developing a Valid Test. The validity of a test can
   only be estimated. But there are known techniques
   that can be used in developing a valid test.

   To determine item content validity, the initial pool
   of test items should be examined on an item-by-item
   basis to see if each appears to measure what it was
   intended to measure. The examination involves two
   steps: making systematic comparisons between training
   objectives and the test items designed to measure
   these objectives, and having SME's review the objec-
   tives plus the test items developed to measure them.

   The SME review should result in revisions of the test
   items with respect to required tasks, applicable con-
   ditions, and scoring standards. The review should
   also examine administrative feasibility and define the
   standardized testing conditions. This process should
   produce content-valid test items which are usable for
   the test.

   The test items must then be validated empirically by
   testing the performance of two groups of subjects.
   One group should be experts (masters) in the perfor-
   mance requirement the lesson is to support. The other
   group should be novices (nonmasters). The test is
   administered to both groups. The test items which
   discriminate between masters and nonmasters are to
   be considered valid (i.e., valid items are those
   which most masters pass and most nonmasters fail).
   The items that do not discriminate should be con-
   sidered invalid, and eliminated from the test.
   The procedure should be repeated using different
   students until an empirically valid test is developed.

o Establishing a Reliable Test. There are many methods
  that can be used to estimate a test's reliability.
  The split-half method divides a test into two parts.
  These half tests are scored, correlated, and used in
  an additional calculation to estimate the reliability
  of the test.

  The test is administered as though it had never been
  split. The test is scored to produce two separate
  scores: one for the odd-numbered items and one for
  the even-numbered items. The scores are correlated.
  The test is modified as required until it is both
  valid and reliable.

Individual Trial Phase. An individual trial is conducted by trying
instructional materials individually on 3 to 5 students representative
of the target population. The purpose is to identify those areas within
the lesson that require revision to insure instructional effectiveness.

Small Group Trials. If no problems are identified in the final indi-
vidual trials, these trials may be bypassed. Small group trials are
conducted by simultaneously trying instructional material on 6 to 10
students who are representative of the target population, but not includ-
ed in the individual trial.

Effectiveness Testing Phase. The effectiveness testing phase is the
most important aspect in the development of training effective TEC lessons.
In this phase, it will be determined whether the lesson is truly effec-
tive with the soldiers for whom it was designed.

o Determining the Target Audience and Drawing a Sample.
  The target audience consists of the entire popula-
  tion of soldiers to be trained by the lesson.

  The next step is to draw a representative sample from
  the target population. The sample must be representa-
  tive of the population - not confined to some peculiar
  subgroup, such as highly trained personnel, or especially
  selected personnel - so that the results of the testing
  can apply to the whole population. It is impractical
  to draw randomly from the total population; therefore,
  a sample must be drawn from the subpopulation available.
  After identifying the subpopulation, there are several

ways to draw the actual sample of 30 or more soldiers
to participate in lesson training. A simple and
practical method is to obtain an ordered list of SSN's
(across units) and to sample systematically from the
list. For example, if there are 500 troops in the
desired MOS at an installation and a sample of 35 is
needed, an SSN listing for the 500 troops should be
obtained and every fourteenth one selected for the
sample. This will provide 35 names out of the 500.
Since some of these people will not be available for
testing, every fifteenth name is taken as an alternate
for the preceding name on the list. Although this is
not a strictly random process, it will yield an essen-
tially random sample of the subpopulation because there
are normally no systematic biases in either SSN assign-
ments or list aggregation.

o TEC Lesson Testing Methods. In TEC contracts let to
date, there are two methods for testing TEC lessons -
The "fixed sample" method and the "sequential testing
sample" method.

When using the fixed sample method, the number of soldiers
to be tested are selected in advance (at least 30). They
are given the pretest, the TEC lesson, and the posttest.
The lesson is accepted if, for each training objective (TO),
the proportion of sampled soldiers passing the posttest
for the TO exceeds the prespecified criterion value.

The sequential testing sample method requires making a
number of entries on a set of charts (one for each TO)
after scoring each test. Based on these entries, a de-
cision is made whether to accept the lesson, reject it,
or go on to the next test. The chart is discussed in
a subsequent paragraph.

o Pretest Administration. Before administering the pretest,
the students should know the purpose of the test and the
lesson following it. During the conduct of the test, the
testers must maintain an impartial attitude. Students
passing the pretest cannot continue in the evaluation
process. Feedback should not be provided to students who
don't pass, because they may learn the test and not the
lesson objectives.

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o   Lesson Administration. Since the goal is to determine
    the training effectiveness of a TEC lesson, the test
    situation should duplicate the real learning situation.

    When a TEC lesson is ready for evaluation in a large
    group trial, there will usually be only one copy available.
    For this reason, most schools elect to present the lesson
    to the sampled soldiers in groups of five or more at a
    time, rather than have each soldier review the lesson
    individually. However, when a lesson is viewed in a group
    mode, there is little or no self-pacing. For certain
    tasks, the lack of self-pacing may decrease the effec-
    tiveness of the lesson.

o   Posttest Administration. The posttest normally does not
    differ from the pretest. After the posttest, each trainee
    should be provided with the results of the test, and each
    trainee should be questioned about the quality and accept-
    ability of the lesson. Although trainee comments have
    no bearing on the acceptability of the lesson in the
    statistical sense, they should be considered seriously
    and identified faults should be corrected.

Validation Decision Making Phase. This phase of TEC effectiveness
evaluation is critical. In addition, it is perhaps the most complex
phase. This section presents only the sequential sampling approach to
the validity decision process. With this technique, one can feel con-
fident that soldiers in the population will be trained to the selected
criterion with the least expenditure of manpower and other resources.

o   Scoring by Objective. All posttests are scored with
    the pass-fail criteria defined for each objective.
    School personnel must define the criteria beforehand
    and make a scoring key for the posttest. Each soldier's
    responses on the posttest are scored with this key.
    After individual responses are scored, it is determined
    whether the soldier has passed or failed with respect
    to each training objective. The GOs and NO GOs for each
    soldier are used to determine whether the lesson is
    training effective for each objective. The scores are
    entered on the appropriate charts, in the order scored,
    to preserve the validity of the process.

Sample Target Audience.

Some method of random selection should be used to obtain 30 soldiers for large group validations. Soldiers that pass the pretest should be eliminated from the validation.

Validation of Training Doctrine.

The validation of TEC lessons should be used as a tool to verify the accuracy of the doctrine and the effectiveness of the training procedures contained in the lesson. The TEC lesson should reflect the best and most current training material available. If the validation process discloses a better training technique, or if the TEC lesson is the first major training medium to be fielded after a change in training doctrine, it should contain that information.

The personnel responsible for TEC validation should be charged with the additional responsibility of validation of the training doctrine. If the validation uncovers problems concerning the validity of the doctrine, the development process should be halted until doctrinal questions are resolved.

Lesson Enhancement.

The following points should be considered for their potential of increasing TEC usage:

     o The TEC developer must have a finite description of the target audience.

     o The medium selected should have a high probability of being used by the target audience.

     o The audiovisual lessons should utilize the full potential of the medium - using motion as necessary to illustrate the performance of critical tasks.

     o The lesson should include enrichment information to assist in learning and understanding or to maintain soldier interest.

     o The level of complexity must be such that the lesson is not a bore to the average soldier.

Quantity vs. Quality.

The number of TEC lessons produced by each school should be adjusted to insure that adequate resources (SME's, hardware, test soldiers, etc.) are available to result in high quality products.

Hands-on tests are not being used for hardware-oriented lessons.

As a rule, the validation process does not include verification of the training doctrine contained in the lesson. Additionally, there is a general perception that the TEC lesson must reflect the exact same material located in another official reference (FM, TM, SM, etc.).

Many lessons fail to utilize the full potential of the audiovisual media. Some material is lifted directly from a printed mode. There was no motion in six lessons that addressed firing weapons and operating vehicles.

Several lessons fail to provide the enrichment information necessary for effective learning or full understanding of the task.

If lesson content and support provided for validations are valid indicators, the schools are trying to develop more TEC lessons than available resources will adequately support.

In general, the sample target audience is not being scientifically selected, only 15 soldiers are used for large group validations, and soldiers that pass the pretest are not eliminated from the validation.

SUGGESTED IMPROVEMENTS

Subject Matter Experts.

The SME must be actively involved in all phases of lesson development - to include being available, as required, on the validation site. The SME involvement should be of an "official" nature, in that SME contributions to the development effort are reviewed by the SME's supervisor.

Hands-on Tests.

Hands-on tests must be included in the validation to fully evaluate training effectiveness.

CONCLUSIONS

All observed personnel associated with the TEC program were considered to be competent and dedicated. The observed problems result more from their being caught up in a bureaucratic system and inadequate SME influence than from the lack of individual effort.

All schools appear to be using the TEC Manager's Guidebook as a basis for their TEC development efforts. Personnel are familiar with the guidelines and variance from guidelines is normally a function of making adjustments considered necessary to accomplish the mission with available resources.

All test soldiers are properly briefed on the purpose of the validation and the role they are expected to perform.

All pretests are administered and scored in accordance with the guidelines. No feedback of pretest results is being provided to test soldiers.

During large group validations, some lessons are administered to groups as large as 15; however, the lesson presentations appear to be effective in that all personnel have a clear view of the screen and the duration of each pause is adjusted for the slowest person.

Posttests are administered following the lesson and all results are properly recorded on appropriate forms.

Feedback from test soldiers is obtained and given consideration in lesson revisions.

All problems with the lesson or with individual training objectives that are discovered during the validation are corrected on the spot or recorded for subsequent corrective action. This is also true for lessons that have otherwise been fully validated.

Of five schools and three different contractors observed, a harmonious and cooperative relationship appears to exist between schools and contractors.

The SME does not have sufficient influence on lesson development. The full participation of the SME is essential to the development of valid and effective lessons.

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Additionally, previous experience indicates that the brighter soldiers are more inclined to take advantage of off-duty job enhancement aids such as TEC. Another factor to be considered is the inability of the Beseler Cue See to bypass material. Even though a soldier may be fully knowledgeable of a portion of the lesson, he must watch the entire lesson at normal speed. Many lessons offer little viewing incentive to the soldier that can read. Why would a soldier view the shot group analysis lesson for marksmanship training when nothing is provided except what is already clearly depicted on the Shot Group Analysis Card?

Two lessons on transformation involve filling out two forms - the time required to complete these lessons is estimated at 4-1/2 hours using a calculator and 9 hours without a calculator. This is a long and complex but seldom used technique. No SQT would ever require the forms to be completed. The lessons provide little information except the guidance that is already on the form. It is the opinion of the observer that these lessons will seldom be used by the target audience.

Enrichment Information.

As in the above examples, most TEC lessons observed failed to provide a hint of why a procedure is performed or its relative importance to other procedures. This type of information would assist in understanding that it is more serious to run an engine without oil or water than with a tachometer that is 50 RPM too high at idle, and that trigger squeeze is more important to marksmanship than the precise placement of the finger on the trigger. Additionally, this information could eliminate confusion: Why is the gas turned on prior to cranking the Vulcan Carrier in the summer and turned off prior to cranking in the winter?

The Validation Requirement.

TEC validation appears to be old hat and has fallen into the realm of something else that has to be accomplished. A standard format/procedure, based on TRADOC guidelines, is used; however, there seems to be no rigid adherence to any policy. Changes are freely made to accommodate lack of troop support, lack of equipment, lack of knowledge, and to speed up the validation process. The schools should make a decision on validation requirements for each lesson. A good review by a knowledgeable subject matter expert may contribute more to a valid lesson than a go-through-the-motions validation.

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Trainer/Developer Interface.

During the development and validation of a TEC lesson, the lesson developer gets very familiar with many training requirements that could be simplified through a minor change or modification to a specification or item of hardware.

Observation of TEC lessons reveals that training requirements have not been given adequate consideration by technical personnel. The training requirements in the lessons are presented exactly as the information comes from a technical manual. For example, in one lesson the soldier is taught to remember that it is very important for the tachometer of a certain vehicle not to exceed 2975 RPM. It is impossible to read 2975 RPM on the tachometer even when the vehicle is not moving, while a reading of 3000 can be read accurately with ease. The additional 25 RPM of engine speed would be negligible on the life of the engine and drive train. In the same lesson, the soldier is taught that if the temperature is above 40° F, he should warm the engine for 3 to 5 minutes at 800 to 1000 RPM and then idle at 550 to 600 RPM. If the temperature is below 40° F, warm the engine for 3 to 5 minutes at 550 to 1000 RPM and then do a second warm-up for 5 minutes at 1200 to 1500 RPM and then warm the transmission for 3 to 10 minutes at 800 to 1000 RPM. The soldier is also required to memorize such things as temperature, oil pressure, and air pressure readings. Most of these readings must be taken from gauges that give no indication of minimum or maximum operating limits. A simple color code on the gauges would greatly enhance training. It appears that the complexity of the training could be significantly reduced if some procedure was available to get the technician and trainer together.

The Target Audience.

During these visits, several soldiers were heard to complain that a particular TEC lesson was an insult to their intelligence. A major objective of the validation is to insure that the lesson teaches the target audience. In an effort to produce a good product, some very high validation criteria have been established. If 90% of the target audience is required to respond correctly to 90% of all items, it logically follows that the difficulty level and complexity of each lesson must be adjusted to allow soldiers with the lowest intellectual capacity to achieve a 90% performance after one viewing. There should be an awareness that the simplicity of many lessons appears to be a turn-off for some soldiers.

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of the lesson, and there should also be enough flexibility to make changes necessary for the most effective presentation of the material in an audiovisual mode.

The personnel involved with TEC validation should be charged with the validation of the doctrine and training procedures contained in the lesson as well as the effective teaching of training objectives.

Subject Matter Expertise.

The purpose of this effort was to evaluate the procedures being used to validate TEC lessons. Except for the lack of hands-on performance tests, no major problems were evident. However, several questions are raised concerning the validity of the doctrine/training procedures contained in the TEC lessons.

The "system" has resulted in non-subject-matter-experts being assigned the primary responsibility of producing a large number of TEC lessons which cover a broad range of subject areas. The constraints of time, the lack of validation personnel who meet minimum prerequisites, the scarcity of hardware, subject-matter experts and test facilities, contribute to a "cut the corners" approach to TEC development.

There are no subject matter experts (SME) directly responsible to the personnel charged with the development of the TEC lessons. The SMEs perform this function as an additional duty and seldom have major input when the paper is blank. The lack of adequate SME influence and ill-conceived doctrine, coupled with improper validation procedures, result in some products that appear less than satisfactory.

Working under the assumption that the effectiveness of the validation process may be judged by an evaluation of the product produced by the process, three of the audiovisual lessons were informally examined to determine the technical accuracy of the doctrine presented and to determine what contribution the lesson content may have to the actual performance of the task in the real world.

All lessons observed were in the final stages of development; therefore, it is doubtful that major changes have been made to lesson content. The critique of selected lessons at Appendix B is intended to show the lack of adequate SME influence and to support previous and subsequent comments.

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focused more on the short term memory capability of test soldiers than on the validity or accuracy of the doctrine or training procedure contained in the lesson. Also, since there were no hands-on performance tests for hardware-oriented lessons anywhere in the development cycle, there was no assurance that the lesson actually presented the material necessary to perform the required tasks.

But what if the material comes directly from a Field Manual? Most schools operate under the policy that all material contained in a TEC lesson must be supported by a current Field Manual (or similar authority) or a final approved draft. This policy has the obvious advantage of keeping everything uncomplicated in that the TEC lesson tracks with the FM, Soldier's Manual, SQT, etc. Since the TEC lesson can't vary from current doctrine, the TEC developer and contractor should have minimal changes to their contract time schedule. Additionally, since the developers of TEC lessons don't claim to be subject matter experts, it makes their job easier because they don't have to vary from what is in the "book." However, this policy tends to focus attention on the validation of the lesson as written while avoiding any validation of the doctrine or training procedures being addressed. More time and money is expended in the validation of some TEC lessons than in the validation of the original doctrine or training procedure upon which the lesson is based. Therefore, in effect, time and effort is expended to validate the training of unvalidated doctrine. Unfortunately, the TEC lesson will normally validate because of the validation procedures used. It appears the Army has much to gain if TEC validations could be used to verify current doctrine and the most effective training procedures.

Changes to Army training literature/media are slow. When a change is made, it normally takes years to reflect that change in Field Manuals, Soldier's Manuals, TEC lessons, etc. TEC lessons should contain the best and most current doctrine and training procedures. The TEC lessons produced today should provide maximum assistance to the soldier in properly and effectively performing his job. The requirement that all TEC material be contained in a Field Manual that may be several years old and can't be revised for two years does nothing to enhance the TEC lesson.

It appears that the content of many TEC lessons is transferred from a Field Manual to an audiovisual format by a non-subject matter expert. A subject matter expert should be involved in the lesson development (not just as a consultant) to insure the most current doctrine is reflected, to provide correct emphasis to the critical teaching points

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pre- and posttest were not treated as firm testing criteria. When
test soldiers had difficulty with a posttest question, for about one-
half of the cases observed, corrective action was directed at changing
the question rather than changing lesson content to better teach the
task. All pre- and posttests for hardware-oriented lessons were of
paper-and-pencil type--no hands-on testing. It is difficult to ade-
quately evaluate training effectiveness without using a hands-on-the-
equipment performance test. Additionally, in no case was the test
itself validated prior to use in the lesson validation.

The Memory Game.

In all cases, the pre- and posttest were the same and, in most
cases, the pre/posttest was nearly identical to the self-evaluation
contained in the lesson. Sometimes the entire validation is accomplish-
ed in one hour. This includes the pretest, the lesson which includes
a review of each question and the self-evaluation, and the posttest.
Since a hands-on test was not required, the obvious question of rote
memory must be given some consideration. Of all TEC validations ob-
served, only one pretest/posttest question was noted as being different
from the self-evaluation questions contained in the lesson. This in-
volved an instrument panel with six gauges. When used in the pretest,
all six gauges were shown with readings that were within the normal
operating range for the particular vehicle. As normal, no feedback
of pretest results was provided. During the lesson, instrument panels
were shown several times, but each time at least one gauge reflected
an improper reading. The correct/incorrect reading of each gauge was
clearly presented and each gauge was shown several times with a correct
reading; however, every soldier missed the posttest question that showed
an instrument panel with all gauges correct. A retention test, following
initial lesson exposure by only a few days or a few hours, may add sig-
nificantly to the validity of posttesting.

What is Validated?

This question concerns the responsibility of personnel developing
TEC material to verify or confirm the validity of the doctrine or train-
ing procedure contained in the TEC lesson. As an example, the TEC
writers may develop an item which is incorrect and a newly assigned SME
may concur with the item. This is presented to test troops (questions
and answers) four times in a short time interval and then they are asked
the question on the posttest. If 90% of the test troops have a good
memory, or if they are allowed to keep the answers they wrote during the
lesson, the item will validate. In effect, the TEC validations observed

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Lesson Administration.

Three of the audiovisual lessons were administered by projecting 35mm slides on a large screen and coordinating it with audio. The duration of each pause was determined by the slowest test soldier. The Armor School used the Singer Caramate II with four soldiers sitting directly in front of the small screen. The printed test lessons were administered on an individual basis, each soldier moving through the lessons at their own pace.

Posttest Administration.

All posttests were conducted immediately following the lesson. Normally, a few minutes were provided for the test soldiers to review notes taken during the lesson and the test was administered without the use of notes. In one case, the soldiers were allowed to retain all notes taken during the lesson. No equipment or hands-on performance tests were included in the validation of hardware-oriented lessons.

Lesson Validation.

Each school had somewhat different criteria for the lessons undergoing validation. The pass rate required for a lesson to validate ranged from 70 to 100 percent, based on the importance rating assigned by the schools to a particular task or group of tasks. All posttest results were properly recorded on the appropriate forms.

Responsibility for Validations.

The contractor is technically responsible for the conduct of the validation, but, in practice, it appears to be a coordinated effort between the schools and the contractors.

DISCUSSION

Pre- and Posttest Development.

Without a valid posttest to measure the training effectiveness of a lesson, there is no way to determine if the lesson is effective. Criterion referenced test items should be developed prior to the design of the lesson. The impression from these visits was that the

OBSERVATIONS

Sample Target Audience.

All lessons observed were undergoing large group validation. The actual number of soldiers utilized for these validations varied from six to thirty, with approximately fifteen being the normal objective. Four of the five schools stated that fifteen was the maximum number of soldiers that could realistically be obtained for the purpose of TEC validation. Some schools conduct all validations at the home installation, while others conduct validations both at home and in field locations. In all cases, the constraints of time, personnel, money, and equipment received primary consideration in these decisions. The method of selecting the sample target audience was normally by rank and MOS, with this commitment often being part of the post-wide detail requirements. Some soldiers were over-qualified, some had an MOS that did not relate to the lesson, and some were "professional TEC validators" in that they would volunteer every time their unit had a requirement to provide soldiers for the purpose of TEC valida- tion. Part of the problem associated with the sample target audience appears to be linked to something less than a clear understanding of precisely who would use the lesson when it was fielded.

Testing Methods.

The fixed sample method of testing was used by four of the five schools. The Armor School used a modification of the sequential test- ing method - 30 soldiers were scheduled for the validation, but the lesson was administered to only four soldiers at a time. Most schools used the sequential charts for recording test results.

Pretest Administration.

All pretests were generally conducted in the same manner - the pre- test was administered, scores were recorded, and no feedback was pro- vided to test personnel. In all cases, the pretest and posttest were exactly the same. Criteria were established for the elimination of the personnel based on a high level of performance on the pretest; however, no personnel were eliminated. In one case, 60% of the sample target audience passed the pretest, and in another, virtually all would have passed if they had been given adequate time and motivation to com- plete the pretest.

If the lesson satisfactorily meets the criteria on
all training objectives (and if there are no other
indications of quality or acceptance problems), the
lesson will pass on to the final stages of develop-
ment, production, and distribution. If the lesson
achieves the criteria with respect to most of the
objectives, it should probably be revised and re-
tested. Scrap only those lessons which totally
fail to train on the major objectives. Revise any
lesson which fails to validate with respect to any
training objective. This process must be performed
fully and accurately to insure that soldiers in the
field get a "certified training effective" lesson.

PURPOSE

To determine the current practices and procedures used by the
service schools to validate TEC lessons and to evaluate the effective-
ness of validation efforts.

PROCEDURE

During the period August to November 1978, TEC validations being
conducted by five different service schools were observed by personnel
of Litton-Mellonics and the Army Research Institute. The table at
Appendix A provides data concerning each visit. In general, these were
informal visits conducted for the purpose of observing TEC validation
procedures and formal feedback was not provided to the schools concern-
ing the findings of these visits.

Three schools were validating hardware-oriented audiovisual lessons
(Infantry, Armor, and Air Defense). The Artillery School was validat-
ing audiovisual lessons which involved filling out forms, and the Signal
School was validating several printed text lessons which focused on the
handling of messages in a communications center. All general points
discussed are based on observations and impressions at two or more
locations.

TEST DATA:

STUDENT:		STUDENT:	
A	GO	H	NO GO
B	GO	I	GO
C	NO GO	J	GO
D	GO	K	GO
E	GO	L	GO
F	GO	M	GO
G	NO GO	N	GO

HIGH	75%	LESSON NO.	_____
DESIRABLE	65%	KIT TITLE	_____
LOW	55%	OBJECTIVE NO.	_____
$\alpha = .05$ $\beta = .25$		CERTIFICATION	_____
		(SIGNATURE OF U.S. GOV. REP)	
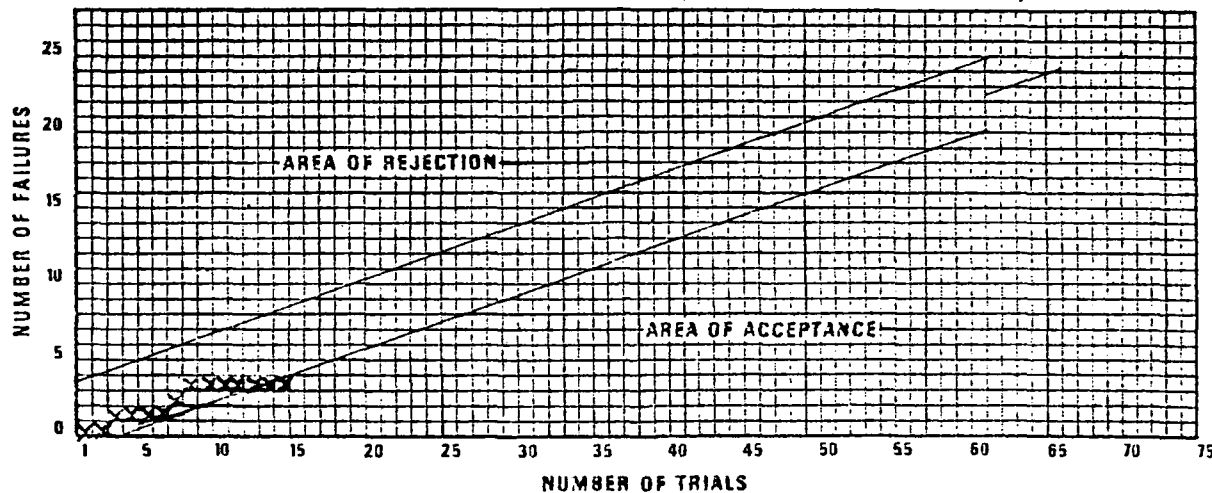
Figure 1: Sequential Testing Chart

o Acceptance/Rejection of TEC Lesson by Objective.
   When the above procedures are completed, the charts
   will reflect whether the training objectives are
   successful or unsuccessful. Then a decision must
   be made with respect to the total lesson. The follow-
   ing questions should be asked: Is the lesson effec-
   tive enough to be sent forward for final development?
   Is it worth revising where it is weak? Or is it so
   poor that it should be scrapped?

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o Selecting Charts for Each Training Objective. The
  TEC contracts include five distinct charts for the
  sequential scoring process. These charts are used
  to evaluate the training effectiveness of the TEC
  lesson with respect to each objective. The chart
  to be used for each objective is determined by the
  importance rating assigned to that objective.

o Plotting GO/NO GO Scores. The sequential testing
  charts are graphs on which the GO/NO GO scores of
  each soldier are plotted with respect to an indi-
  vidual objective. Five numbers are given on each
  chart. Three of the numbers represent a "high,"
  "desirable," and "low" value for the percent of
  soldiers receiving a GO for a given training ob-
  jective. Two of the numbers are called alpha (a)
  and beta (b). These numbers are interpreted as
  follows:

  "a" is the probability that an objective will
  be rejected if the percent of soldiers in the
  target population who would receive GO for that
  objective, if they viewed the lesson, is equal to
  the "high" value.

  "b" is the probability that an objective will be
  accepted if the percent of the soldiers in the
  target population who would receive GO for that
  objective, if they viewed the lesson, is equal
  to the "low" value.

  The horizontal axis counts the number of trials
  (soldiers taking the test) and the vertical axis
  counts the cumulative number of NO GOs. The graph
  is simply a mechanical way to determine whether the
  lesson should be accepted or rejected, based on the
  results of the tests, for that objective. The
  parallel lines on the chart mark the regions for
  acceptance or rejection.

  Usually the result of a test is a mixture of GOs
  and NO GOs, rather than a situation that results
  in all GOs or NO GOs. In this example (see Figure 1),
  it takes 14 trials to reach the accepted area.

School	Date of Visit	Personnel Conducting Visit	Lessons Undergoing Validation
Infantry	20-23 Aug 78	Mr. Osborne[1]	#939-071-0214F Zeroing the M16A1 Rifle - Aiming and Firing Techniques.
			#939-071-0215F Zeroing the M16A1 Rifle - Analyzing and Correcting Errors.
Field Artillery	26-27 Sept 78	Mr. Osborne[1]	#412-061-7972-F Transformation of Coordinates
			#412-061-7973-F Transformation of Azimuth
Armor	28-29 Sept 78	Mr. Osborne[1]	#944-171-0109-F During Operation Maintenance Checks on the Five Ton Truck.
Air Defense Artillery	10-11 Oct 78	Dr. Holmgren[2] Mr. Osborne[1]	#043-441-5978-F Operating the Vulcan Carrier, Part III
			#043-441-5979-F Preventive Maintenance Checks and Services for the M74 Vulcan Carrier, Part I
			#043-441-5980-F Preventive Maintenance Checks and Services for the M74 Vulcan Carrier, Part II
Signal	17 Nov 78	Dr. Holmgren[2] Dr. Morey[1] Mr. Osborne[1]	#580-113-6501A Thru 7A Incoming Paper Tape Messages
			#580-113-6510A and 11A Process Incoming Card Messages
			#580-113-6552A and 3A Telecommunication Center Files

[1]Litton-Mellonics
[2]ARI

APPENDIX B

CRITIQUE OF SELECTED TEC LESSONS

These comments are based on the premise that the effectiveness
of TEC lesson review and validation procedures can be judged by a
critical examination of the completed TEC lesson. The comments con-
cerning technical accuracy of lesson content are based on the opinion
of the author and some points may be questionable. However, it is
believed that this review accomplishes the intended purpose of pro-
viding strong evidence that lesson content leaves something to be
desired.

Zeroing the M16A1 Rifle - Analyzing and Correcting Errors.

The soldier is directed to have the Rifle Shot Group Analysis Card
(GTA 21-1-4) in hand when this lesson is viewed. The problems with
this lesson begin with the card (Figure 2), which is filled with faulty
information. Sight alinement is presented as the most important factor
in shooting the M-16. The sight alinement sketch that shows the path
of the bullet if an error is made in sight alinement is reproduced in
one of the lesson visuals. Emphasis is placed on sight alinement
several times as being "most critical," bullets will be "way off,"
"won't be near the target," "lucky if he found any holes," etc. The
infatuation with sight alinement seems to stem from the fact that the
error increases with range. It is impressive. The sight radius on
the M-16 is 50.17 centimeters or about 1/2 meter. This means that
any error made in the alinement of the front and rear sights will be
multiplied 50 times at 25 meters, 200 times at 100 meters, and 600 times
at 300 meters. However, the sketch shows the front sight post about
1/4 of the distance between the center and the inside edge of the rear
sight. The rear sight aperture is 2 millimeters from side to side -
1 millimeter from the center. Therefore, the sight misalinement de-
picted, .25 millimeter, times 600, is equal to 150 millimeters or
something less than 6 inches. This means that the 19-1/4 inch silhou-
ette would be hit at 300 meters - not missed by 40 inches. The accu-
racy of this information has been confirmed by several live firing
tests; however, it can be verified by spending a few minutes on any
range.

The top two shot groups on this card, long vertical and long hori-
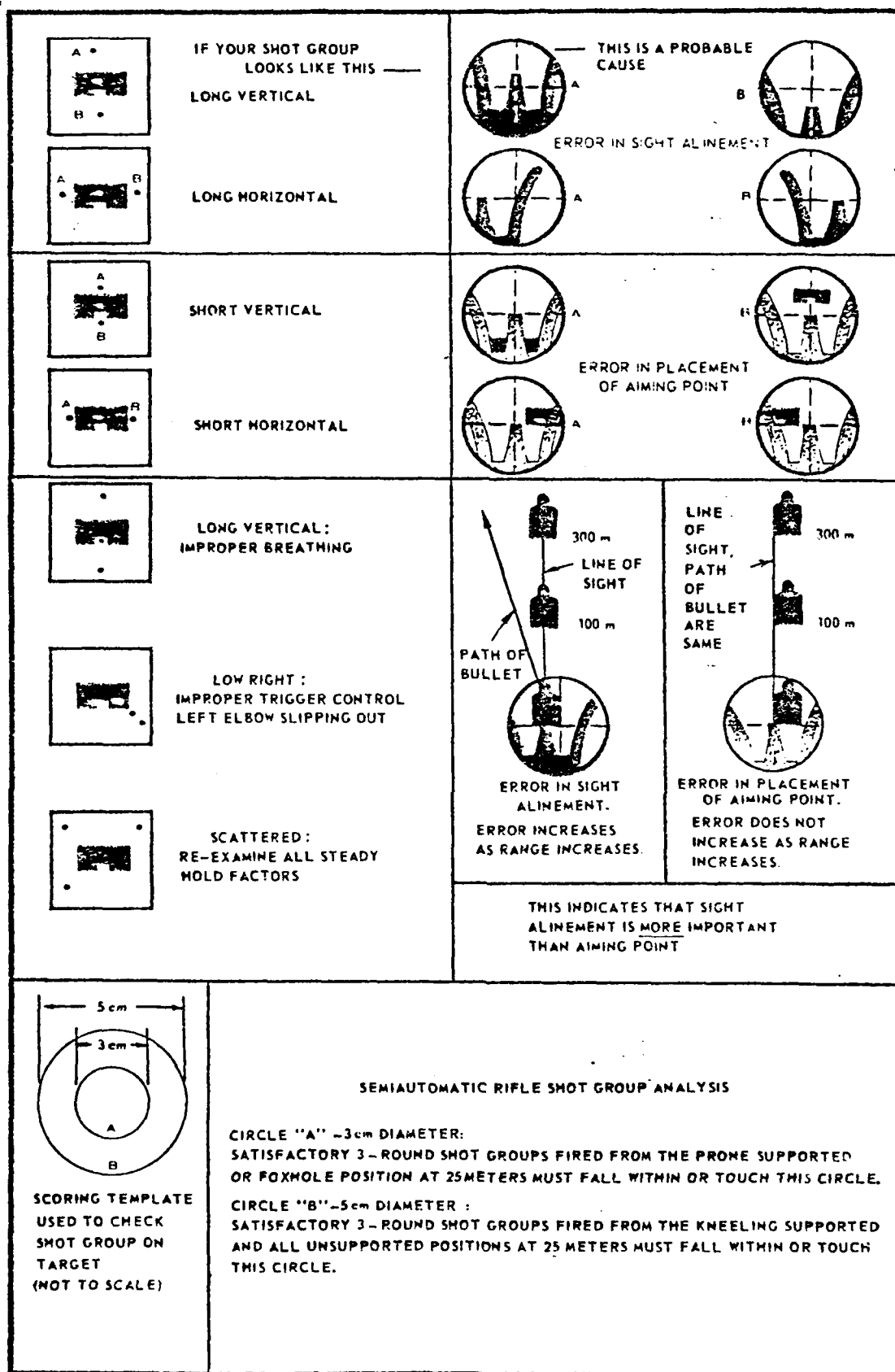zontal, are incorrect for four reasons:

IF YOUR SHOT GROUP LOOKS LIKE THIS —— LONG VERTICAL

THIS IS A PROBABLE CAUSE

ERROR IN SIGHT ALINEMENT

LONG HORIZONTAL

SHORT VERTICAL

ERROR IN PLACEMENT OF AIMING POINT

SHORT HORIZONTAL

LONG VERTICAL: IMPROPER BREATHING

LOW RIGHT: IMPROPER TRIGGER CONTROL LEFT ELBOW SLIPPING OUT

SCATTERED: RE-EXAMINE ALL STEADY HOLD FACTORS

300 m

LINE OF SIGHT

100 m

PATH OF BULLET

ERROR IN SIGHT ALINEMENT.

ERROR INCREASES AS RANGE INCREASES.

LINE OF SIGHT, PATH OF BULLET ARE SAME

300 m

100 m

ERROR IN PLACEMENT OF AIMING POINT.

ERROR DOES NOT INCREASE AS RANGE INCREASES.

THIS INDICATES THAT SIGHT ALINEMENT IS MORE IMPORTANT THAN AIMING POINT

5 cm

3 cm

A

B

SCORING TEMPLATE USED TO CHECK SHOT GROUP ON TARGET (NOT TO SCALE)

SEMIAUTOMATIC RIFLE SHOT GROUP ANALYSIS

CIRCLE "A" —3cm DIAMETER:
SATISFACTORY 3 – ROUND SHOT GROUPS FIRED FROM THE PRONE SUPPORTED OR FOXHOLE POSITION AT 25METERS MUST FALL WITHIN OR TOUCH THIS CIRCLE.

CIRCLE "B" —5cm DIAMETER:
SATISFACTORY 3 – ROUND SHOT GROUPS FIRED FROM THE KNEELING SUPPORTED AND ALL UNSUPPORTED POSITIONS AT 25 METERS MUST FALL WITHIN OR TOUCH THIS CIRCLE.

Figure 2: Shot Group Analysis Card

o Per the above discussion.

o It is obvious that the analysis is made based on
an assumption that the rifle is zeroed; therefore,
all bullet strikes should be shown 2.4 centimeters
below point of aim - not the same as point of aim.

o The alinement error depicted is more than an indi-
vidual can unknowingly make. If the sights are
misalined as shown for "long horizontal A," the
rear sight aperture will be darkened to such an
extent that this could not logically be an unin-
tentional error. A look through the sight of an
M-16 rifle will verify this point.

o The average M-16 rifle with service ammunition is
only capable of firing shot groups with a spread of
1/2 inch to one inch at 25 meters. The firer may
be expected to add another 1/2 inch to this probable
error. Therefore, each bullet fired may strike 3/4
of an inch, in any direction, from the point of aim -
all other sources of error at a minimum. It seems
absurd to assume that sight alinement error will be
either perfectly vertical or perfectly horizontal
and even more absurd to assume that these perfectly
vertical or horizontal errors will result in per-
fectly vertical or horizontal placement of shots.
The other five shot groups depicted on the card are
as erroneous as the two discussed above.

The target in the lesson has squares of 1.4 centimeters and a 5.2
centimeter zeroing template is used. By the time this lesson is
fielded, it is expected that a target with .7 centimeter squares
and a 4 centimeter zeroing circle will be in standard use.

In effect, this lesson validated because the soldiers were capable
of looking at a placement of shots on the shot group analysis card and
relating that to the exact same placement of shots on the posttest.
A soldier completing this lesson should be capable of analyzing a shot
group and identifying the probable cause of unsatisfactory groups.
There is no indication that personnel viewing this lesson can analyze
real shot groups.

Failure to question material contained in a Field Manual, coupled
with the failure to conduct hands-on testing, has resulted in the per-
petuation of erroneous training doctrine.

Zeroing the M16A1 Rifle - Aiming and Firing Techniques.

The primary problem with this lesson is that emphasis is placed on the wrong points.

The use of the eight steady hold factors to teach firing techniques is a questionable procedure, since few of the eight factors can be directly related to getting the bullet on target. However, a discussion of that idea would be beyond the scope of this paper. In any case, some factors are much more important than others in obtaining an effective zero.

Trigger control is the most important of the eight steady hold factors - trigger squeeze being the key to good shot groups. Rearward trigger pressure is mentioned twice with the same emphasis as 40 other items while placing too much finger on the trigger receives major emphasis. The point is made at least four times, reinforced with visuals, that only the tip of the finger must be on the trigger. In fact, most M-16 rifles require 7-10 lbs. of pressure to pull the trigger, and for many people, putting more than the finger tip on the trigger improves their firing performance.

The other point that receives major emphasis in the lesson is the placing of the rifle directly on the sandbag support - the lesson states that this is wrong, that it should never be done. The basic fundamental of getting a good zero is to hold the weapon in a steady position; therefore, the full utilization of all available support should be encouraged. There is nothing wrong with placing the weapon directly on the support during the zero process. An argument could be made for this being a better procedure; however, the point is that it is clearly not one of the 40 items covered in the lesson that should be selected to receive special emphasis.

This lesson clearly indicates the lack of adequate SME influence. Additionally, a brief firing exercise would demonstrate that the points receiving major emphasis in the lesson have no positive influence on the strike of the bullet.

During Operation Maintenance Checks on the Five-Ton Truck.

The organization of this material is questionable. The objective is to present before, during, and after operation maintenance checks for the M809 and M39 trucks, and the material is organized into three lessons -- before, during, and after checks for the M809 and M39.

However, there are numerous differences between the two vehicles that the student is asked to put to memory (idle speed, temp, oil pressure, air pressure, etc.). A more logical organization appears to be two lessons, each covering before, during, and after checks for each series of vehicles.

The lesson appears to be about two trucks, the M809 and the M39. The technical manual (TM) indicates that there are 20 different models of the M809 series and 12 different models of the M39 series (cargo, wrecker, dump, van, etc.). The maintenance checks discussed in this lesson apply to all 32 models. It seems appropriate to mention this and to show some pictures. The lesson currently makes no visual distinction between the M809 and M39.

The lesson states that the M39 may be Diesel or Multifuel. According to the TM, it may be Diesel, Multifuel, or Gas. The lesson makes reference several times to the M39 Multifuel when it should just reference the M39.

The lesson requires the soldier to memorize the idle speed of 700 RPM. In fact, the idle speed on these vehicles ranges from 400 to 800 RPM. The lesson currently directs the soldier to check the idle for his particular vehicle, but it seems useless to remember 700 since that will not apply to any vehicle. The lesson teaches that if the idle is not at the designated setting, the driver should cease operations, stop the motor, and report this to organizational maintenance. In fact, the idle adjustment is a minor maintenance problem. It should be noted on the Form 2404 and reported to maintenance personnel, but the driver should not cease operations while on a mission.

The lesson teaches that if the tachometer is in the red, the driver should cease operations, stop the motor, and report to organizational maintenance that the engine is racing. This is like telling a traffic cop that you were speeding because the gas pedal was mashed down too far. The engine is racing because the driver has the pedal to the metal. This condition is corrected by lifting the right foot or changing to a higher gear.

The lesson teaches that the oil pressure at 35 MPH is 25-70 lbs. for the M809 and 50-65 lbs. for the M39. In fact, this is the normal range for highway driving and a constant 35 MPH pressure would be in a more narrow range.

The lesson teaches that if the oil pressure gauge is not correct and the oil level is correct, the driver should report that he has a faulty oil pressure gauge. This is incorrect. It is not a safe bet that the gauge is bad. The driver should report that his oil pressure reading is incorrect.

The lesson teaches that a water temperature of 195 degrees is dangerously high and that the driver must cease operations and stop the engine. This is incorrect. In fact, temperatures up to 200 degrees are considered normal for these trucks under heavy work conditions. Additionally, it is impossible to get an exact reading of 195 degrees from the gauge while 200 degrees can be read with precision. The guidance to the driver should be to check his vehicle and report to maintenance any time the temperature exceeds the normal range, but he should not cease operations during a mission until the gauge exceeds 200 degrees.

The lesson teaches that when the vehicle overheats (195 degrees), the driver should cease operations, stop the engine, and wait 20 minutes. After waiting 20 minutes, he should check the water - if the water is OK, check the oil - if the oil is OK, report the condition to organizational maintenance. The 20 minute wait is necessary to allow the radiator to cool so that the driver is not burned from escaping steam and so that coolant is not wasted. There is no need to wait to check the oil level. As a matter of fact, there are two other checks the driver can make immediately that will be more probable causes of overheating (assuming the before operations checks were made). These are checking the radiator to insure the radiator fins are not clogged and checking to insure that the fan belt is not loose or broken. Therefore, for overheating, the soldier should be taught to stop the engine and immediately check to insure the fan belt is OK, the radiator is clear of anything that could block the full passage of air, the oil level is correct, and then if these items are correct, wait 20 minutes and check the coolant level.

The discussion of the air restriction indicator immediately follows the discussion of the pressurized air system that operates the brakes. An unknowledgeable individual may assume that the two systems are the same. The lessons should make it clear that these are separate systems.

The discussion of the air restriction indicator may leave an unknowledgeable individual with the idea that the air restriction indicator

should be cleaned when red shows in the sight glass. In fact, the air cleaner should be cleaned. Showing a picture of the air cleaner seems appropriate.

This lesson reflects a lack of adequate SME involvement in the TEC development process.

APPENDIX C

ADDITIONAL OBSERVATIONS

These observations and impressions are not directly related to the validation of TEC lessons, but are considered to be of some significance to the TEC program.

The Printed Text Media.

The most impressive validation observed was a validation of several printed text lessons. It is believed that the media selected contributed significantly to this impression for the following reasons:

o The lessons addressed message formats and communication center procedures which appeared to be ideally suited for presentation in a printed text format. All personnel in this MOS are required to read and write.

o The printed text format allows the student to view the lesson in the final format--a true one   one situation--and provides for self-pacing during validation.

o There were sufficient personnel (normally five) on hand to properly control the validation and insure that necessary lesson revisions were recorded.

o There appeared to be no questions from a doctrinal content point of view. The lessons addressed well established procedures which are straightforward. The lesson, in final form, is readily available for wide review.

o All posttests required a realistic performance of the actual task being taught by the lesson.

The TEC Managers Guidebook lists the relative advantages of printed text: flexibility in lesson design, student access, mobility (field use), ease in updating/revisions, and low cost. The relative advantages

of audiovisual are listed as: student interest/motivation, inadequate reading skills, requires visual movement presentation, and presentation of psychomotor and perceptual skills. All of the eight TEC lessons previously observed undergoing validation could have been presented in a printed text mode. Some psychomotor skills were involved, but there was no presentation of visual movement in any lesson. Most of the information could have been presented well within the reading capability of the target audience. This leaves only the question of student interest/motivation. If the interest is there, will the soldier be more motivated to visit the learning center (perhaps on his own time) to view the audiovisual lesson, or would he be more likely to pick up a printed text lesson and take it with him to his job site? The printed text also has some operational capabilities which the Cue See does not have--it has a fast forward, a fast reverse, a repeat and looping capability, and the heads never have to be cleaned.

The Army Training System.

If the primary focus of training should be on combat performance, there is little evidence that adequate consideration has been given to the total Army training system. For example, the training system should result in a high probability that soldiers with an 82C MOS will be capable of performing an accurate zone to zone transformation when the task is required in combat. A detailed analysis of this training problem would probably list, as first priority and most cost effective, a revision of DA Forms 4212 and 4259. An audiovisual TEC lesson would probably be on the bottom of the priority list.

Selection of Subjects.

An overview of all lesson validations and a general sensing that resulted from the visits indicate that there has been a push to make a large number of TEC lessons. It appears that subjects have been listed as candidates for audiovisual TEC lessons without adequate concern for the suitability of the subject matter and what the usage level of the lesson may be.

Use of Art Work.

Art work is used for all visuals when, for many, a photograph may better accomplish the purpose of the visual - and be much cheaper. Additionally, it was noted that at least two schools were developing basic operator maintenance lessons for the M113 chassis. It appears that much of the art work would be applicable to all lessons that involve the 113 chassis.